

## Chapter 6 HW Answers

### Review Questions:

7. None. At 0 K there is no more energy that can be removed.
21. When the temperature is decreased this will cause the entropy to be decreased.
23. A substance that heats up quickly has a low specific heat capacity; it changes temperature easily.

### Exercises:

8. Compressing air is doing work on the air, and the work is transformed into energy. This energy increase results in an increase in temperature.
12. Yes. The rock will lose energy to the ocean; the rock and the ocean will come into thermal equilibrium. However, the energy will be dispersed in the vast ocean and will not change the overall temperature of the ocean.
13. The jug of water is the better choice because it will maintain its temperature longer and will give you steady warmth through the night. The brick would transfer its heat to you quickly making you too hot initially, and then you would be cold when the heat transfer stopped.
14. Sand's specific heat capacity is very low; it changes its temperature very quickly.

### Problems:

2.  $m = 5 \text{ grams} = 0.005 \text{ kg}$
- $d = 6 \text{ cm} = 0.06 \text{ m}$  (distance mail is moved when work is done on it)
- $F = 500 \text{ N}$
- $c = 450 \text{ J/kg}^\circ\text{C}$

Work done becomes heat energy

$$\text{Work} = \text{Heat energy}$$

$$W = Q$$

$$Fd = cm\Delta T$$

$$\Delta T = \frac{Fd}{cm} = \frac{(500 \text{ kg m/s}^2)(0.06 \text{ m})}{(450 \text{ J/kg}^\circ\text{C})(0.005 \text{ kg})} = \mathbf{13.3} \text{ }^\circ\text{C}$$

Additional:

A. The hammer does work on the penny, and this work is transformed into energy within the penny. This energy increase results in an increase in temperature.

B.  $m = 1250 \text{ g}$   $c = 452 \text{ J/kg}^\circ\text{C}$  (for steel)  
 $h = 40 \text{ ft} = 12.2 \text{ m}$   $g = 9.81 \text{ m/s}^2$  (because object is falling)  
 $\Delta T = ?$

The energy at the top is:  $GPE = mgh$

The energy at the bottom is:  $Q = cm\Delta T$

$$GPE_{\text{top}} = Q_{\text{bottom}}$$

$$mgh = cm\Delta T \quad \text{mass cancels}$$

$$gh = c\Delta T \quad \text{now solve for } \Delta T$$

$$\Delta T = \frac{gh}{c} = \frac{(9.81 \text{ m/s}^2)(12.2 \text{ m})}{452 \text{ J/kg}^\circ\text{C}} = \mathbf{0.26} \text{ }^\circ\text{C}$$

C. The first task is to calculate the heat energy to change the temperature for each. Then, compare, in physics, means to take a ratio.

$$Q = cm\Delta T$$

Water:  $Q = (4186 \text{ J/kg}^\circ\text{C})(0.05 \text{ kg})(100 \text{ }^\circ\text{C}) = \mathbf{20,930 \text{ J}}$

a. Copper:  $Q = (387 \text{ J/kg}^\circ\text{C})(0.05 \text{ kg})(100 \text{ }^\circ\text{C}) = \mathbf{1,935 \text{ J}}$

$$\text{Compare} \quad \frac{\text{Copper}}{\text{Water}} \quad \frac{1,935 \text{ J}}{20,930 \text{ J}} = \frac{1}{10.8}$$

**10.8 times more energy to heat the water**

b. Lead:  $Q = (128 \text{ J/kg}^\circ\text{C})(0.05 \text{ kg})(100 \text{ }^\circ\text{C}) = \mathbf{640 \text{ J}}$

$$\text{Compare} \quad \frac{\text{Lead}}{\text{Water}} \quad \frac{640 \text{ J}}{20,930 \text{ J}} = \frac{1}{32.7}$$

**32.7 times more energy to heat the water**

c. Alcohol:  $Q = (2450 \text{ J/kg}^\circ\text{C})(0.05 \text{ kg})(100 \text{ }^\circ\text{C}) = \mathbf{12,250 \text{ J}}$

$$\text{Compare} \quad \frac{\text{Alcohol}}{\text{Water}} \quad \frac{12,250 \text{ J}}{20,930 \text{ J}} = \frac{1}{1.7}$$

**1.7 times more energy to heat the water**

D. The nails lose heat to the water.

Heat lost by Nails = Heat gained by Water

$$Q_{\text{lost}} = Q_{\text{gained}}$$

$$c_n m_n \Delta T_n = c_w m_w \Delta T_w$$

$$(452 \text{ J/kg}^\circ\text{C})(100 \text{ g})(70^\circ\text{C}) = (4186 \text{ J/kg}^\circ\text{C})(100 \text{ g})\Delta T_w \quad (\text{mass cancels})$$

$$31,640 \text{ J} = (4186 \text{ J/}^\circ\text{C})\Delta T_w$$

$$\Delta T_w = 7.6^\circ\text{C}$$

**Bonus:**

The final temperature of the water is  $20^\circ\text{C} + \Delta T_w$ .

$$T_f = 27.6^\circ\text{C}$$